UNITED WATER DELAWARE **SUSAN SKOMORUCHA**

WWW.UNITEDWATER.COM

2000 First State Blvd., P.O. Box 6508 Wilmington, DE 19804-6508 TEL 302-252-3035 FAX 302-633-5910 SUSAN.SKOMORUCHA@UNITEDWATER.COM2009 JUN 29 AM 10: 21

DELAWARE

PSC DOCKET

Ms. Karen Nickerson Commission Secretary Public Service Commission of Delaware 861 Silver Lake Blvd. Cannon Building, Suite 100 Dover, Delaware 19904

NO. 0 9 - 2 8 2

June 26, 2009

RE: IN THE MATTER OF UNITED WATER DELAWARE INC. FILING THE CERTIFICATION OF ADEQUATE SUPPLY AND CONSUMER WATER CONSERVATION PLAN

Dear Secretary Nickerson:

In accordance with Title 26 of the Delaware Code relating to the Water Supply Self-Sufficiency Act of 2003, Chapter 14. Self-Sufficient Water Supply, § 1404 relating to reporting requirements for jurisdictional water utilities, enclosed are the original and ten (10) copies of the above mentioned filing of the Certification of Adequate Supply for the projected year 2012.

Please note for the purpose of this reporting period that the water supply demand numbers published for United Water Delaware by the WSCC do not reflect the loss of two of United Water Delaware's customers, Chrysler Corporation and Pepsi Co., as well as an ancillary customer, Lear, who supplied car seats to Chrysler. All combined, these customers have previously had significant consumption demands on United Water Delaware's production

Should you have any questions concerning the enclosed, please contact me at (302) 252-3035.

Very truly yours,

Susan Skomorucha **General Manager**

Enc. (10)

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DEL AWARE DAM

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UNITED WATER DELAWARE Certification of Adequate Water Supply

United Water Delaware 2000 First State Boulevard, P.O. Box 6508 Wilmington, DE 19804-6508

July 1, 2009



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1.0 INTRODUCTION

On August 4, 2003, Governor Ruth Ann Minner signed into law, H.B. 118, the "Water Supply Self Sufficiency Act of 2003". The intent of the law is to ensure that water utilities, both public and private, "...have adequate supplies of water available, even in times of drought, to meet the present and future needs ..." In accordance with H.B 118 § 1403(a) the Water Supply Coordinating Council has determined, published, and transmitted to the Delaware Public Service Commission the projected demand for each water utility providing water utility services in the drought sensitive area north of the Chesapeake and Delaware Canal. The projected demand for the projected year of 2009 for United Water Delaware (UWDE), as determined by the Water Supply Coordinating Council, is 23.6 million gallons per day (mgd).

This submission to the Delaware Public Service Commission is in fulfillment of the following requirements of H.B. 118:

§1404. Reporting requirements for jurisdictional water utilities: consumer water conservation plans and certifications of adequate supply.

- (a) On or before July 1 of a reporting year, each jurisdictional water utility in the drought sensitive area shall file with the Commission:
 - (1) a consumer water conservation plan (Plan) for the following 3-year period; and
 - (2) a certification of adequate water supply (Certification) for the projected year.

The Plan and Certification must be applicable to the water utility services provided by the jurisdictional water utility in the drought sensitive area.

United Water Delaware's Water Supply Certification, filed with the Public Service Commission on July 1, 2006, provided details regarding the Company's facilities as well as supporting evidence of reliable quantities of supply from various sources. This document intends to provide updates to supplemental information to that which was provided in the July 1, 2006 certification filing.

United Water Delaware will meet the 2012 projected demands of 24.5 million gallons per day using the Stanton and Christiana Water Treatment Plants in



combination with other sources of supply. The added supply provides operating advantages to the company when chlorides become problematic.

Table 1
United Water Delaware Sources of Supply Table Summary

	MGD	MGD	MGD
	Available	Available	Available
	Summer	Summer	Summer
	2006	2009	2012
Stanton WTP	20.60	20.60	20.60
Christiana WTP	3.25	3.25	3.25
City of Wilmington	3.80	5.53	5.53
Interconnections			
CWA Interconnection	0.24	0.24	0.24
UW Bethel Interconnection	0.43	0.58	0.58
ASR	0.00	0.80	1.00
Total	28.32	31.01	31.20

Projected demand as set by the Water Supply Coordinating council is 24.5 mgd.

Details about the changes in United Water Delaware's 2009 Sources of Supply as shown in the above table are described herein.

2.0 PRIMARY SOURCES OF SUPPLY

<u>Stanton Water Treatment Plant</u> – There are no changes to availability of supply from the Stanton Water Treatment plant which was previously certified at 20.6 mgd.

Hoopes Reservoir - Hoopes Reservoir releases are included in the Stanton Plant's certified supply rating of 20.6 mgd. A new agreement for raw water releases from the City of Wilmington's Hoopes Reservoir was negotiated in 2007 and, with the exception of the expiration date, the terms of the agreement have remained the same. The new agreement expires on December 31, 2012. A copy of the current agreement is provided in Exhibit 1.

<u>Christiana Water Treatment Plant</u> – There are no changes to the availability of supply from the Christiana Water Treatment Plant which was previously certified at 3.25 mgd.



3.0 SUPPLEMENTAL SOURCES OF SUPPLY

3.1 AQUIFER STORAGE RECOVERY WELL 1 (ASR-1)

ASR-1 was placed into service in October 2008. Test cycling proved successful storage and recovery of 10 mgd. The well is designed for storage and recovery of 75 mgd at a rate of 1 mgd over a 75 day period. Based on current status, 60 mg is expected to be stored and available for recovery during 60 days in summer 2009. Future recharge cycles are planned to store 75 mg from November through June which would provide 1 mgd recovery during July, August and September 2010. This schedule provides for two full operational cycles of 75 mgd each by 2012. A sealed Engineer's report that summarizes the aquifer capabilities and the ASR facilities is provided by design engineer Ch2MHill in Exhibit 2.

3.2 Interconnections

<u>Artesian Water</u> - There are no changes to the status of interconnections with Artesian Water. Since there are no current agreements for the use of interconnections with Artesian Water, these interconnections are not included in the supply certification.

<u>Chester Water Authority (CWA) at Post Road</u> -There are no changes in the status or terms of the interconnection agreement with the CWA for Post Road. This interconnection was previously certified at 0.24 mgd and a copy of the agreement was provided in the 2006 Water Supply Certification filing.

<u>United Water Bethel (UW Bethel)</u> - There are no changes to the status or terms of the agreement with UW Bethel at the State Line location. At this interconnection UWD purchases excess water from UW Bethel which has been supplied to UW Bethel by the CWA at UW Bethel's Smithbridge Interconnection. Using the same approach as in the 2006 certification, historical drought month supply (July through September) for the past 4 years is plotted and a straight-line trend to 2012 is applied. A 20% reduction factor is used because the water is originating from the CWA which has, during past droughts, requested a 20% reduction. The projected quantity available from this interconnection has increased, since the 2006 filing most likely due to a reduction in usage in the Bethel system. The trended data is provided in Exhibit 3.



<u>City of Wilmington (CoW)</u> - There are no changes to the status or terms of the agreement with the CoW. The agreement provides for up to 10 mgd of finished water to be provided. Since the 2006 water supply certification, two additional interconnections, Governor Printz Boulevard and Concord Square, have been activated and/or installed. Also, one new interconnection, Rail Car Avenue, is proposed to be constructed in late 2009. The current total finished water available from the CoW has increased from 3.80 mgd to 5.53 mgd.

<u>Atlas, Chatham and Silverside Road Interconnections</u> - There are no changes to availability of supply from these locations. These interconnections continue to provide 3.80 mgd of the certified supply.

Governor Printz Interconnection – This interconnection was not considered in the 2006 certification. It has been reactivated and was flow tested at a rate of 1.58 mgd (1100 gpm). An engineer's report describing this interconnection and the flow test results is provided in Exhibit 4.

Concord Square Interconnection – This new interconnection, constructed in 2008, is hydraulically designed to provide for fire flow capacity. As a fire flow rate far exceeds normal demands, for the purpose of this supply certification, billing records are used to establish the available supply. Billing records indicate the area served through this interconnection represents an average of 0.14 mgd (100 gpm). An Engineer's report describing this interconnection is also provided in Exhibit 4.

Rail Car Avenue Interconnection - An interconnection at Rail Car Avenue is currently planned to be constructed in late 2009. Hydraulic modeling by both the City and UWD predict that this interconnection can provide up to 2 mgd. No credit is taken in this certification for the additional proposed interconnection.

4.0 CONSUMER WATER CONSERVATION PLAN

As part of the required filing, United Water Delaware's Consumer Water Conservation Plan for 2009-2012 is provided in Exhibit 5.

Nancy J. Trushell, P.E. Director of Engineering



5.0 CERTIFICATION OF WATER SUPPLY SELF-SUFFICIENCY

the documentation provided in this report, United W sources of water supply available to meet projected de record in northern New Castle County through the year	emands through a drought of
Dennis Ciemniecki President – Regulated Business	6/22/09 Date
Susan Skomorucha General Manager	<u>UJJJ09</u> Date
Nancy Trustell, PE.	6/22/09

I, Dennis Ciemniecki, do hereby certify that, to the best of my knowledge and by

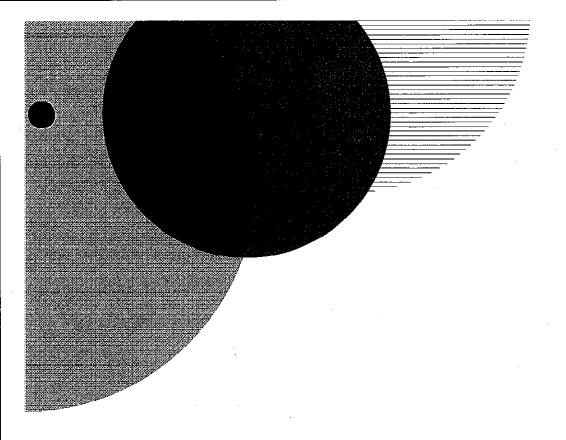


Exhibit 1

Agreement between City of Wilmington and United Water Delaware For Hoopes Releases





AGREEMENT BETWEEN THE CITY OF WILMINGTON and UNITED WATER DELAWARE INC.

WHEREAS, the City has a source of unfinished (raw) surface water located at Hoopes Reservoir which is collected from the Brandywine River in accordance with the Delaware River Basin Commission ("DRBC") regulation; and

WHEREAS, United is an investor-owned water utility, regulated by the Delaware Public Service Commission ("PSC"), serving water customers in New Castle County; and

WHEREAS, United has a demonstrated need for additional supplies of unfinished water at certain times during emergency and/or drought conditions.

NOW, THEREFORE, the City and United, in consideration of the mutual promises and covenants set forth herein, agree as follows:

- 1. Purpose: The City shall release and sell, and United shall accept and buy, unfinished water to supplement United's water supplies during emergency and/or drought conditions subject to the terms and conditions set forth herein. The City shall release the water from Hoopes Reservoir into the Red Clay Creek so that United may process the unfinished water at United's treatment facilities.
 - 2. <u>Annual Reservation and Fee Structure:</u>
- (a) <u>Annual Reservation Charge</u>: In consideration of the City making the supply of water available to United as set forth within, United agrees to pay an annual reservation (or standby) charge to the City of Twelve Hundred Dollars per One Million Gallons

(\$1,200 per 1,000,000 Gal). The annual reservation charge shall be determined by multiplying (1) the volume of water reserved for United in any one annual period, times (2) \$1,200.

United shall make its initial request for the specific amount of the annual reservation of water as contemplated by this Agreement on or before March 1, 2008, and by March 1 of each contract year thereafter. The City will provide written acknowledgement confirming the volume reserved by United within thirty (30) days upon receipt thereof. At no time during the term of this Agreement shall the annual reservation exceed Two Hundred Million Gallons (200 MG) or fall below Fifty Million Gallons (50 MG).

- charge of Four Hundred Dollars per One Million Gallons (\$400 per 1,000,000 Gal) of unfinished water. This charge shall be in addition to the annual reservation charge and shall be applied to the actual quantity of water released by the City on request of United. United agrees that all such quantities of water released by the City into the Red Clay Creek pursuant to the terms of the Agreement shall be measured and determined by the City through its Department of Public Works.
- (c) Excess Release Charge: In the event that United requests the City to release water in excess of the agreed upon reservation volume within the applicable contract year, and the City agrees to make an additional release, United shall pay the City an excess release charge of Two Thousand Dollars per One Million Gallons (\$2,000 per 1,000,000 Gal) for such excess release.
- (d) <u>Metering:</u> The City shall provide a meter with a continuous recording-totalizer device to record the volume of water released. Said meter and

appurtenances shall be tested at least annually by City. United may, upon reasonable request to the City, test or have the meter tested. The cost of meter tests performed by United or at its request, other than the annual test performed by the City, shall be paid by United. If said meter shall be found to be in error by more than allowable AWWA standards, the current and two preceding billings for water released, if appropriate, shall be adjusted to reflect the correct usage, and the City shall reimburse to United the reasonable cost of the test that disclosed such information.

- 3. <u>Limitation on Rate of Release</u>: The volume of unfinished water provided by the City to United shall not exceed a daily amount of Five Million Gallons (5,000,000 Gal), such volume of water to be processed by United at its facilities. However, volumes may be adjusted by the Commissioner of Public Works if warranted in the sole discretion of the City. The release of unfinished water by the City shall not exceed an instantaneous flow rate of Ten Million Gallons (10,000,000 Gal) per Day; provided, however, the City shall be responsible for installing any necessary instrumentation to measure instantaneous flows.
- 4. <u>Payment</u>: Payment of the annual reservation charge shall be made by
 United to the City in full within thirty (30) days of the submittal of the request for the
 annual water reservation. Payment for any water released shall be made by United within
 thirty (30) days of the date of the invoice rendered by the City.
- 5. <u>Indemnification</u>: United agrees to defend, indemnify, and save harmless the City from any and all claims, actions, fees, charges, and expenses of any kind, including attorney's fees, caused by the negligence of United or arising out of this Agreement and imposed by the DRBC, the Delaware Department of Natural Resources and Environmental Control ("DNREC") or any other federal, state or local authority pursuant to any and all applicable federal, state or local statues and regulations.

- 6. <u>Late Payment</u>: In the event United fails to pay on the due date all sums due and owing to the City at any time during the term of this Agreement, United shall pay to the City interest at the then current prime rate for the Wilmington Trust Company and any such reasonable costs incurred by the City as determined by the City's Director of Finance.
- 7. Change of Law: In the event any federal, state, or other agency having jurisdiction over the subject matter of this Agreement and the City imposes requirements upon the City whether pursuant to existing or future laws, statutes, or regulations which render impossible the performance of this Agreement, then upon six (6) months notice to the other party, the party affected by such regulations shall be entitled to declare this Agreement null and void, save any outstanding payment owed hereunder. Should such requirements create a situation of less than total impossibility, United may at its option continue this Agreement by agreeing to pay, incur, or otherwise satisfy any additional expenses or costs caused by such requirements, and an amended written agreement may be entered into by the parties setting forth the revised undertaking. If acceptable terms cannot be agreed upon within three (3) months after the imposition of said conditions or additional requirements, then this Agreement shall become null and void save any outstanding payments owed to the City. During the negotiation period, the City, at the discretion of the Commissioner of Public Works, may refuse to release any additional water if, in his opinion, such release would be detrimental to the City or its water customers.
- 8. <u>Destruction of Water System</u>: In the event that there shall be a significant destruction or disablement of the City's water system or any part thereof, this Agreement may be held in abeyance by the City, without penalty, upon written notice to United, until such time as said destruction or disablement is sufficiently repaired to allow City to render performance hereunder. If such destruction or disablement cannot be repaired within a

reasonable time, this Agreement shall be terminated; provided, however, that the City shall upon such termination refund United any annual reservation charges on a pro rata basis or usage charges for water not used by United as of the date of termination.

- 9. Treatment Required: United understands that the water supply contemplated is unfinished, that treatment by United is required, and United agrees to defend, indemnify, and hold the City harmless, including the cost of the defense of all claims and litigation, arising from or alleging unsuitability or contamination of any water supplied by United to its customers.
- 10. No Assignment: The parties hereto shall not assign, subcontract or otherwise transfer the Agreement or any portion thereof except with written consent of both parties; provided, however, that if the stock or assets of United are transferred to another entity acquiring all or substantially all of the same, and such entity assumed all of the obligations of this Agreement in writing, then such assignment shall be effective upon written notice to the City.
- 11. <u>Complete Agreement</u>: The Agreement contains the full and complete understanding between the City and United and supersedes all previous agreements and/or proposals, whether oral or written.
- 12. <u>Term</u>: The term of this Agreement shall commence upon execution of this Agreement and shall automatically reach termination on midnight December 31, 2012, unless further extension is mutually agreed by the parties prior to such time and date.
- 13. This Agreement shall not impact or restrict any rights that United may have to purchase water, finished or unfinished, from the City, under an agreement between United and the City dated October 2, 2000.

14. IN WITNESS WHEREOF, the parties hereto have duly executed this Agreement on the day and year aforesaid in Wilmington, Delaware. THE CITY OF WILMINGTON Signed, sealed and delivered in the presence of: ATTEST: UNITED WATER DELAWARE INC ATTEST: Secretary Approved as to form Jan. 23

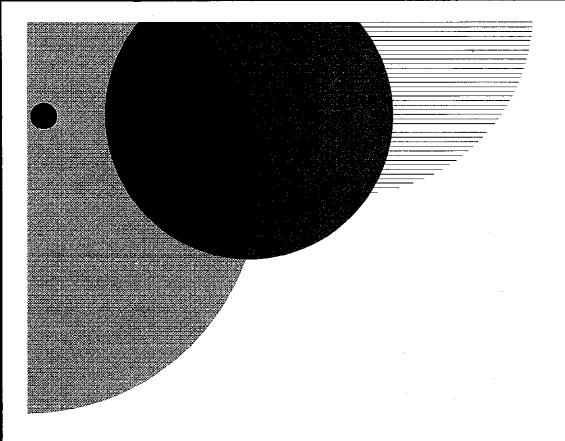


Exhibit 2 Ch2MHill Engineer's Report Certifying ASR



Water Supply Certification for United Water Delaware Aquifer Storage and Recovery Facility at St. George's Crossing, New Castle, DE

Prepared for United Water Delaware

June 2009



1717 Arch Street Suite 4400 Philadelphia, PA 19103

Mark Lucas, P.G.
Registration No. 002991

Water Supply Certification for United Water Delaware Aquifer Storage and Recovery Facility at St. George's Crossing, New Castle, Delaware

PREPARED FOR:

United Water Delaware

PREPARED BY:

CH2M HILL

DATE:

June 9, 2009

PROJECT NUMBER:

161679.G0.CA

Introduction

This memorandum intends to provide a water supply certification in accordance with the requirements of Delaware's Public Service Commission (PSC) for United Water Delaware's (UWDE) Aquifer Storage and Recovery (ASR) facility at St. George's Crossing in New Castle, Delaware (Figure 1). Geologic, hydrologic, water quality, and ASR testing (cycles) has been conducted at the St. George's site since late 2005 with the intention of developing a successful ASR facility. An ASR well was installed at the site in 2006, followed by construction of the ASR facility, comprising a building, electrical, chemical feed, and instrumentation and control systems. The new facility was placed in service in October 2008.

ASR is a water supply management concept whereby treated drinking water is recharged to a suitable aquifer through a well(s) when system capacity exceeds demands. The water is, stored, and then recovered from the same well(s) when demands exceed system capacity. In the eastern United States, ASR operates on a seasonal basis to meet peak period water demands. Typically, only disinfection, pH adjustment, and system specific finished water additives are required before use in the distribution system.

At UWDE's St. George's Crossing ASR facility, ASR operations will be conducted in annual cycles. Each consists of recharge, storage, and recovery periods. Water will be recharged for 285 to 290 days over the low demand (winter, fall, and spring)months. The recharge period will be followed by a short (3 to 5 day) storage period. Water will be recovered from ASR-1 for 70 to 75 days to meet late summer/early fall demands.

To date, three abbreviated ASR test cycles have been completed at volumes ranging from 2 to 10 million gallons (MG). A fourth cycle will run to the end of summer 2009. Upon completion of the cycle projected storage for the end of July, will approach 60 MG for recovery to meet late summer 2009 water demands in the UWDE distribution system.

All required permits were obtained for the new ASR facility through the following county and state agencies:

New Castle County Department of Land Use

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- New Castle County Department of Special Services
- Delaware Health and Social Services, Division of Public Health, Office of Drinking Water (ODW)
- Delaware Department of Natural Resources and Conservation (DNREC) Underground Injection Control (UIC) Group
- DNREC Water Supply Group
- New Castle County Soil Conservation District

ASR Well

UWDE's ASR facility consists of a single, 18-inch by 12-inch diameter well (ASR-1) set in the Lower Potomac Aquifer. ASR-1 extends to 675 feet below grade, and contains 91 feet of 12-inch diameter, stainless steel continuous wrap well screen. The screen covers sand beds (562 to 620 feet below grade, and 632 to 665 feet below grade) in the Lower Potomac Aquifer split by a blank section (Figure 2).

Two viable storage aquifers lie beneath the St. George's facility (Figure 3). These units include the upper (Upper Potomac) and lower (Lower Potomac) sand units of the Potomac Aquifer system. Both units are confined above by thick, silty clay units. Local wells screened in the Upper and Lower Potomac Aquifers can produce water at rates ranging from 400 to 1,000 gpm. Thus, aquifers are available to expand UWDE's ASR capacity beyond the capabilities of ASR-1.

Water Quality

Native groundwater quality in both aquifers is good with low total dissolved solids (less than 150 milligrams per liter (mg/L)), neutral pH (approximately 7.0), and no evidence of contamination from anthropogenic sources. However, native groundwater from both aquifers exhibits concentrations of iron (3.3 mg/L) and manganese (0.06 mg/L) elevated above the Delaware Secondary Drinking Water Standard (DSDWS).

ASR Facility

ASR-1 is designed to recharge treated drinking water from UWDE's distribution system into the Lower Potomac Aquifer at rates ranging from 200 to 240 gallons per minute (gpm). Distribution system water originates from UWDE's Stanton and Christiana Water Treatment Plants, which treat surface waters from the White Clay Creek, and Christina River, respectively.

Over a 290-day recharge period, approximately 83.5 MG to 100 MG of water can be stored for peak period use. During recharge, the pH of the recharge water is adjusted from 7.2 to 8.3 using liquid, potassium hydroxide (potash). Increasing the pH of the recharge water passivates iron and manganese-bearing minerals in the matrix of the Lower Potomac Aquifer. Dissolved oxygen (DO) in the recharge water reacts with reduced phase minerals like pyrite in the aquifer to release a ferrous iron ion and the bisulfide ion. Ferrous iron further oxidizes to ferric iron which as a strong oxidant that could potentially perpetuate the pyrite oxidation process. However, ferric iron quickly combines with the available hydroxyl ions provided by the addition of potash, to precipitate a hydrous ferric oxide (HFO) coating(s) on the surface of the pyrite grain.

HFO coatings isolate the mineral grain from further reactions with the aquifer environment. In addition, HFO is highly adsorptive of metal ions migrating in the aquifer environment, including iron and manganese. Thus, during recovery, native groundwater with concentrations of iron and manganese below the DSDWS can be recovered.

ASR-1 can recover water at a maximum capacity of 1,025 gpm for short periods, but will typically operate at 700 gpm (1.0 million gallons per day (MGD)). ASR-1 is equipped with a variable frequency drive to accommodate recovery operations over a range of flowrates. ASR-1 maintained a constant rate of 910 gpm during a formal, 72-hour, constant rate aquifer test. Three chemical feed systems at the facility treat the recovered water before release to the UWDE system. The pH of the recovered water is adjusted with potash, disinfected with sodium hypochlorite, and then fluoride is added at concentrations around 1 mg/L.

ASR Test Cycles

To demonstrate that drinking quality water can be stored in the Lower Potomac Aquifer and recovered meeting all parameters of the Delaware Drinking Water Standards (DDWS), three ASR test cycles have been conducted at ASR-1 The cycles also tested the hydraulic performance of ASR-1 under recharge conditions. Two of the three test cycles were conducted with temporary facilities, while the third cycle was performed in the newly completed facility. Test volumes were increased with each cycle progressing from 2 MG for Test Cycle 1, 5 MG for Test Cycle 2, and 10 MG for Test Cycle 3.

A permit to operate, and recover water directly to UWDE's distribution system was received from Delaware's ODW on October 7, 2008. Recovered water from Test Cycles 1 and 2 was discharged to waste, while Cycle 3 was recovered directly to UWDE's distribution system.

During each test cycle, one to two samples were collected from the recharge water, and five samples were collected of the recovered water. Recovered water samples were collected at intervals coincident with 20, 40, 60, 80, and 100 percent of the recharge water recovered. A pressure transducer/data logger system was installed to measure, and record water levels, and ultimately evaluate the hydraulic performance of ASR-1.

The following sections provide an evaluation of water quality and hydraulic results from Test Cycles 1 through 3.

Mixing with Groundwater

Before evaluating water quality in recovered water, the amount of mixing between the recharge water and native groundwater must be determined. To evaluate the amount of mixing between the native groundwater and recharge water in a storage aquifer, a conservative constituent is tracked throughout the recovery period and compared with its concentration in the recharge and native groundwater. This constituent is nonreactive between the two waters and the aquifer matrix, and exhibits significantly differing concentrations in the recharge and native groundwater.

Chloride generally exhibits conservative, nonreactive behavior in the subsurface. Further, during the three cycles, average chloride concentrations in the recharge water (61 mg/l)

were significantly greater than the native groundwater (7.1 mg/l) of the Lower Potomac Aquifer (Tables 1, 2, and 3).

A graph of chloride concentrations versus recharge volume recovered (Figure 4) suggests that mixing occurred between the native groundwater and the recharge water near the end of the three cycles. Chloride traces between the three cycles follow roughly equivalent paths.

Applying the use of a conservative tracer, a number of analytical techniques provide an estimation of the amount of recharge water in a recovered water sample. Over the three cycles, the percentage of recharge water in each recovered water sample declined from 100 percent at 60 percent recovered to 50 percent at almost 100 percent recovered (Figure 5). The mixing profile gradually, but progressively improved through Test Cycles 1 through 3 with the samples from successive cycles containing a greater percentage of recharge water.

Arsenic and Radionuclides

Because of problems at ASR sites in Florida and Wisconsin, regarding recovering elevated concentrations of arsenic and activities of radionuclides (gross alpha, radium 226, and radium 228), these constituents can be a concern for ASR operations elsewhere. During Test Cycles 1 through 3 at ASR-1, arsenic concentrations were less than laboratory method detection limits (MDL's) in the recharge water, native groundwater and recovered water samples (Tables 1, 2, and 3).

During Test Cycle 2, radionuclide activities were less than laboratory method detection limits (MDL's) for the recharge water, native groundwater, and recovered water samples. During Test Cycles 1 and 3 low activities of radium 228 (228 Ra) were detected in the recharge water sample, but activities in the recovered water were less than MDL's . Gross alpha activities occurred above the MDL in several samples, but never exceeded 3 pCi/L, compared against the DDWS of 15 pCi/L. Radium 226 (226 Ra) activities were above MDL's in several recovered samples from the three cycles, but all were less than 1.0 pCi/L compared against the DDWS of 5.0 pCi/L for a total 226 Ra and 228 Ra activities.

Iron and Manganese

As concentrations of dissolved iron in the native groundwater (2.73 mg/L) are above the DDWS of 0.3 mg/L, recovering concentrations of iron was a water quality concern for ASR operations at St. George's Crossing. Adjusting the pH of the recharge water above 8.30 using potash combined with saturated concentrations of DO in the surface water, derived recharge water was ideal for passivating reduced iron and manganese minerals in the Lower Potomac Aquifer and preventing dissolution of these minerals in the stored water.

Iron concentrations were greatest during Test Cycle 1 ranging from 0.27 mg/L at around 20 percent recovered to slightly less than the Delaware sequestration limit of 0.6 mg/L at nearly 100 percent recovered (Figure 6).

Iron concentrations remained below the DSDWS of 0.3 mg/L in the recovered water from Test Cycles 2 and 3, and were usually less than 0.1 mg/L. The improvement in iron concentrations between successive cycles suggests that the iron bearing minerals in the Lower Potomac Aquifer are being progressively conditioned with a HFO coatings through reactions with DO and potash in the recharge water.

During Test Cycles 1 and 2, the pH of the recovered water ranged from 6.0 to 6.5. The pH throughout the recovery period was less than native groundwater, suggesting that an acid was produced during storage in the Lower Potomac Aquifer. Production of an acid is consistent with the oxidation of reduced iron bearing minerals in the matrix of the Lower Potomac Aquifer (Figure 7). pH reduction during storage appeared to moderate by Test Cycle 3 with no samples below 6.7. The increase in pH between the test cycles suggests that acid producing reactions in the Lower Potomac Aquifer were beginning to subside as the aquifer underwent progressive conditioning.

The effectiveness of HFO as an adsorption media can be observed in the recovered water results from Test Cycles 2 and 3. At 100 percent recovered, HFO sites in the Lower Potomac Aquifer, appear to be removing iron from the native groundwater migrating toward ASR-1. With larger operational cycles, the effectiveness of adsorption in removing iron should progressively improve, while iron concentrations in the recovered water from the early portion of the cycles decline.

The ability to treat native groundwater for iron in situ alleviates concerns with the influence of mixing on recovered water quality.

Manganese typically co-precipitates with iron at approximately 1/10th the concentration of iron, and often fills 1/10th of the iron sites in common minerals. Manganese concentrations in the native groundwater were approximately 1/100th the concentration of iron suggesting that manganese is somewhat deficient in the minerals of the Lower PotomacAquifer.

During Test Cycles 1 through 3, manganese concentrations exhibited a different pattern than iron (Figure 8). Total manganese concentrations increased from 0.025 to 0.043 mg/l, but decreased to 0.04 mg/L at the end of all the cycles. Recovered manganese concentrations were less than the DDWS of 0.05 mg/L. When comparing manganese concentrations between cycles at similar recovered water volumes, manganese concentrations decline significantly on each subsequent cycle (Figure 9).

Trihalomethanes

The formation of trihalomethanes (THM) results from the application of chlorine products to drinking water for disinfection particularly with surface water supplies. THM constituents include: chloroform, bromoform, bromodichloromethane (BDM), and dibromochloromethane (DBM). Other disinfection by- products include haloacetic acids (HAA). Samples of the recharge and recovery waters were analyzed for the THM compounds during all three test cycles, and HAA's during the recovery portion of Test Cycle 2.

THM's can represent a concern for ASR operations because chlorinated surface water is recharged to the storage aquifer, and then disinfected upon recovery. If THM concentrations do not decline during storage in the aquifer, or greater concentrations are generated through reactions in the aquifer environment, then THM concentrations could exceed the DDWS after disinfection, upon recovery.

During the three cycles, THM concentrations in the recharge water averaged around 65 ug/L. Concentrations of chloroform comprised the largest fraction at 33 ug/L with lesser

concentrations of BDM (25 ug/L) and DBM (7 ug/L). Concentrations of bromoform were less than MDL's in the recharge water.

During the recovery portion of Test Cycle 3, total THM concentrations declined from around 25 at 20 percent recovered to less than 1 ug/L, approaching 100 percent. Despite the difference in recharge water volumes, THM concentrations exhibited significant, progressive declines between the three cycles. (Figure 10)

The pattern of THM distribution in the recovered water from the three test cycles was consistent with other ASR facilities storing water in a confined aquifer. Concentrations of brominated THM's decline more rapidly than chloroform (Pyne, et. Al, 1993; Brothers et. Al, 1993). However, with longer storage periods, even concentrations of chloroform decline significantly as demonstrated during Test Cycle 1. HAA concentrations in the recovered water of Test Cycle 2 declined to less than MDL's after 36 percent of the recharge water was recovered.

Hydraulic Performance

During the 72-hour constant rate aquifer test, ASR-1 exhibited a specific capacity of 10 gallons per minute per foot (gpm /ft). Specific capacity pertains to a flowrate for every foot of drawdown, and is a useful index for assessing well performance with time. The original specific capacity value was maintained for Test Cycles 1 through 3, suggesting that no measurable well losses were incurred by clogging during ASR operations. An ASR well is most vulnerable to clogging during recharge when water containing total suspended solids (TSS) is injected through the well screen and filter pack. Routine maintenance such as backflushing events can help remove accumulated TSS.

During Test Cycle 4/ Seasonal Cycle 1, presently in progress, ASR-1 is backflushed once for every seven days of recharge operations. Backflushing involves turning off recharge and turning the well pump on for 30 to 45 minutes. Backflushing reverses the flow direction through the well screen, removing accumulated suspended solids from the screens slots, filter pack, and borehole wall helping to clean the well and maintain hydraulic performance.

Summary

UWDE's ASR facility at St. George's Crossing, currently comprising one ASR well, should reliably store from 83 to 100 MG in the Lower Potomac Aquifer over an annual 290 day recharge period. Testing reveals ASR-1 can recover water at rates approaching 1,025 gpm (1.476 MGD), but operating plans are to recover at 700 gpm (1.0 MGD) with an annual recovery period of 75 days during late summer.

Results from three ASR test cycles indicate that drinking quality water can be recovered from the Lower Potomac Aquifer requiring only minimal treatment (disinfection, pH adjustment and fluoridation). Evaluation of water quality for the three test cycles indicates progressive improvement between each successive cycle for parameters associated with mixing, metals (iron and manganese), aquifer conditioning (pH, sulfate, alkalinity), and THM's.

No loss in well performance was observed over the course of three ASR test cycles. A fourth test/seasonal cycle is presently ongoing with no observable decline in well performance.

Taking into account the occurrence of delays while wringing out recharge operations at the new facility, the seasonal recharge volume for Test Cycle 4/Seasonal Cycle 1 will approach 60 MG. Future operational cycles would be expected to provide the full 75 mgd recharge and recovery as planned.

To date UWDE has received all necessary permits from the state of Delaware's ODW, and DNREC. UWDE awaits approval of Certificate of Occupancy from New Castle County Department of Land Use. This permit will be issued with germination of seeded ground cover at the new facility. A Permit to Operate was issued by Delaware's ODW on October 7, 2009. Thus, water can be recovered directly to UWDE's distribution system. In accordance regulations under DNREC's UIC program, permitting activities will be ongoing through the first several operational size cycles.

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Tables

TABLE 1
Summary of Field and Laboratory Water Quality Test Results

Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery 5	Recovery 6	Federal Drinking Water Standards	EPA Standard Testing Method
Percent Recharge Recovered	%	-1	-,	12	28	55	73	86	100		
Constituent	Units										
Hd	standard units	6.77	8.2*	6.51	6.44	6.48	6.38	6.42	6.35	6.5 - 8.5	
Eh	JW.	-71.5	969	ဟု	73	45	121	10	29		
Specific Conductivity	emhos	139.6	290	281	267	246	221	206	191		
Dissolved Oxygen	mg/L	0.52	8.53	0.00	90.0	0.00	0.02	00.0	00'0		
Temperature	ပ္	16.5	27.2	26.3	25.4	23.4	22.7	21.6	21.0		
Field Iron (dissolved)	mg/L	2.73	0.01	0.31	0.28	0.45	0.47	0.61	0.55	0.3	
Field Iron (total)	mg/L	3.05	0.02	0.35	0.32	0.53	0.54	0.59	0.63	0.3	
Turbidity	NTU	0.68		0.23	0.08	0.24	0.11	0.25	0.36		
Aluminum dissolved	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	200.7
Aluminum total	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	200.7
Arsenic dissolved	mg/L		<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	9000	200.9
Arsenic total	mg/L	<0.0080	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	900'0	200.9
Iron (dissolved)	mg/L	3.1	<0.10	0.19	0.31	0.55	0.52	9.0	0.62	0.3	200.7
Iron (total)	mg/L	3.0	<0.10	0.27	0.33	0.55	¢.	0.62	0.61	0.3	200.7
Manganese dissolved	mg/L	0.048	<0.02	0.03	0.03	0.04	0.04	0.04	0.04	0.05	200.7
Manganese total	mg/L	0.048	<0.015	0.024	0.031	0.042	0.043	0.040	0.038	0.05	200.7

TABLE 1
Summary of Field and Laboratory Water Quality Test Results

		1									Y CU
Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery	Recovery 6	rederal Drinking Water Standards	Standard Testing Method
Percent Recharge Recovered	%	~,	-1	12	28	55	73	86	100		
Constituent	Units										
Magnesium total	mg/L	2.2	11	8.0	7.0	6.3	5.9	5.2	9.4		200.7
Potassium total	mg/L	3.5	5.9	7.5	7.4	7.2	6.4	7.0	6.7		200.7
Sodium total	mg/L	20	20	20	21	24	20	20	20	20	200.7
Calcium total	mg/L	8.7	38	26	25	23	23	9	17		200.7
Sulfate	mg/L	6.0	26	32	32	27	22	€	16	250	300.0
Chloride	mg/L	7.07	52	51	49	46	39	34	29	250	300.0
Alkalinity	mg/L	6.69	65	50	49	84	54	26	28		2320B
Phosphate	mg/L	ı	<0.010	0.021	0.026	0.032	0.012	0.026	0.020		300.0
Nitrate	mg/L	<0.50	2.3	<0.50	<0.50	<0.50	<0.50	<0.50	40.50	10	300.0
Silica	mg/L	1	12.5	8.3	8.1	8.0	8.8	7.1	9.7		370.1
Dissolved organic carbon	mg/L	;	2.2	4.	1.3	1.1	4.1	4.	1.3		
Total organic carbon	mg/L	×1.0		7.	1.3	1.1	1.5	7 .	د .		415.1
Total dissolved solids	mg/L	1	280	230	200	180	170	150	140	200	2540C
Total suspended solids	mg/L	ŧ	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0		160.2
Hardness	mg/L		92	0.99	62	25	22	49	4		
Chloroform	ng/L	<0.50	32	33	30	24	20	16	13	9	524.2

TABLE 1

Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-1

Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2		Recovery Recovery	Recovery 5	Recovery 6	Federal Drinking Water Standards	EPA Standard Testing Method
Percent Recharge Recovered	%	-,	7,	12	28	55	73	86	100		
Constituent	Units										
Bromoform	ng/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	10	524.2
Bromodichloromethane	ng/L	<0.50	-	2.8	1.7	<0.50	<0.50	<0.50	<0.50	10	524.2
Dibromochloromethane	ug/L	<0.50	2.1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		524.2
Gross Alpha	pCi/L	1	<2.44	<1.06				<1.27		15	NJAC 7:18-6
Gross Beta	pCi/L	•	<4.10	2.2				4.64			
Radium-228	pCi/L	·	2.23	<1.01				<0.638		വ	904.0
Radium-226	pCi/L	,	<.718	0.55				<2.22		5	903.1

*Adjusted with KOH

TABLE 2
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-2

Sample		ASK-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery 5	rederal Drinking Water Standards	Standard Testing Method
Percent Recharge Recovered	%	-,	-,	18	36	55	77	97		
Constituent	Units									
Hd	standard units	6.77	8.37*	6.36	6.26	6.27	6.25	6.24	6.5 - 8.5	
듑	AE	-71.5	675	4	-15	7	-50	48		
Specific Conductivity	emhos	139.6	447	377	376	314	293	273		
Dissolved Oxygen	mg/L	0.52	13.8	1.07	0.00	11.9+	00.00	0.20		
Temperature	ပ္စ	16.5	26.37	24.47	24.08	22.84	21.34	20.18		
Turbidity	UTN	99.0	0.0	0.0	0.0	0.0	0.0	1		
Aluminum dissolved	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.2	200.7
Aluminum total	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.28	0.2	200.7
Arsenic dissolved	mg/∟	1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	900'0	200.9
Arsenic total	mg/L	<0.0080	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	900.0	500.9
Iron (dissolved)	mg/L	3.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.3	200.7
iron (total)	mg/L	3.0	<0.10	<0.10	0.10	0.26	0.20	0.31	0.3	200.7
Manganese dissolved	mg/L	0.048	<0.015	0.020	0.032	0.042	0.039	0.039	0.05	200.7
Manganese total	mg/L	0.048	<0.015	0.021	0.032	0.043	0.040	0.039	0.05	200.7
Magnesium total	mg/L	2.2	12.0	8.7	9.0	7.9	6.2	5.2		200.7
Potassium total	mg/L	3.5	9.3	8.1	7.4	7.1	6.5	6.1		200.7
Sodium total	mg/L	20	19.0	18.0	18.0	20.0	20.0	20.0	20	200.7

TABLE 2
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-2

ASR-1 During Test Cycle-2										
Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery 5	Federal Drinking Water Standards	EPA Standard Testing Method
Percent Recharge Recovered	%	-1	-,	18	36	55	11	97		
Constituent	Units									
Calcium total	mg/L	8.7	38.0	29.0	28.0	26.0	21.0	18.0		200.7
Sulfate	mg/L	6.0	26	32	31	28	22	19	250	300.0
Chloride	mg/L	7.07	61	54	53	48	38	32	250	300.0
Alkalinity	mg/L	66.69	80	54	53	56	22	160		2320B
Phosphate	mg/L	ı	1	<0.75	<0.75	<0.75	<0.75	<0.75		300.0
Nitrate	mg/L	<0.50	2.0	<0.50	<0.50	<0.50	<0.50	<0.50	10	300.0
Fluoride	mg/L	ŧ	1.	0.79	99.0	0.55	0.47	0.44	2.0	300.0
Beryllium	mg/∟	•	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.004	200.7
Cadmium	mg/L	1	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.005	200.7
Chromium	mg/∟	1	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.1	200.7
Copper	mg/L		<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	6.7	200.7
Nickel	mg/L	ı	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020		200.7
Silver	mg/L	,	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.10	200.7
Zinc	mg/L	•	.0.45	0.033	0.038	0.046	0.026	0.034	വ	200.7
Antimony	mg/L	·	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	200.9
Lead	mg/L	1	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.015	200.9
Selenium	mg/L	ı	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.05	200.9

TABLE 2
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-2

ASR-1 During Test Cycle-2										
Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery 5	Federal Drinking Water Standards	EPA Standard Testing Method
Percent Recharge Recovered	%	-,	*1	18	36	55	77	26		
Constituent	Units									
Thallium	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.002	200.9
Mercury	mg/L	•	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.002	245.1
Silica	mg/L	•	7	7	80	_O	∞	œ		370.1
Dissolved organic carbon	mg/L	•	1.3	1.2	7:	د 1 .0	1.	1.7		SM20- 5310B
Total organic carbon	mg/L	41.0	1.6	1.5	1.3	4.1	5.7	1:2		415.1
Total dissolved solids	mg/L	ı	240	210	200	180	160	160	200	2540C
Total suspended solids	mg/L	•	<5.0	<5.0	<5.0	<5.0	<5.0	6.0		160.2
Hardness	mg/L	ı	140	110	110	26	į	ı		200.7
Chloroform	ng/L	<0.50	33	32	21	17	9.1	5.5	10	524.2
Bromoform	ng/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	10	524.2
Bromodichloromethane	ng/L	<0.50	15	3.2	<u>.</u> .	7	<0.50	<0.50	10	524.2
Dibromochloromethane	ng/l.	<0.50	5.5	<0.50	<0.50	<0.50	<0.50	<0.50	10	524.2
Total HOAA	mg/L			0.0016	0.0014	,	<0.001	<0.001	90.0	552.2
Monochloroacetic Acid	mg/L			<0.0010	0.0014	•	<0.001	<0.001		552.2
Dichloroacetic Acid	mg/L		1	0.0016	<0.0010		<0.001	<0.001		552.2
Gross Alpha	pCi/L		<2.33^	<2.25		,	3.11	1	15	0.008
Radium-228	DCW.	1	<0.498^	1.39	ı		1.10	•	ເດ	904.0
Radiuili-2.0	7.									1

TABLE 2
Summary of Field and Laboratory Water Quality Test Results
ASP.4 During Test Curles.2

ASR-1 During Test Cycle-2										
Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery Recovery Recovery	Recovery 4	Recovery 5	Federal Drinking Water Standards	EPA Standard Testing Method
Percent Recharge Recovered	%	-,	-,	6	36	55	7.2	97		
Constituent	Units									
Radium-226	pCi/L	,	<0.806^ <0.583	<0.583	•	1	0.651	ı	5	903.1

*Adjusted with KOH +equipment failure?

TABLE 3
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-3

Percent recharge recovered Constituent Units R.32 pH standard units 6.77 8.32 Eh mv -71.5 656 Specific Conductivity emhos 139.6 324 Dissolved Oxygen mg/L 0.52 8.36 Temperature °C 16.5 14.1 Field Iron (dissolved) mg/L 2.73 <0.01 Field Iron (total) NTU 0.68 0.2 Aluminum dissolved mg/L <0.10 <0.10 Arsenic dissolved mg/L <0.10 <0.0030 Arsenic total mg/L <0.0080 <0.0030 Iron (dissolved) mg/L <0.0080 <0.0030 Iron (dissolved) mg/L <0.0080 <0.0030		16.05 6.92 -199 301 1.37	43.78 7.07 -179 281	50 DR				
mv -71.5 ecific Conductivity ermhos 139.6 solved Oxygen mg/L 0.52 mperature °C 16.5 nd Iron (dissolved) mg/L 2.73 Id Iron (total) mg/L 3.05 Indity NTU 0.68 Iminum dissolved mg/L <0.10 senic dissolved mg/L <0.10 senic total mg/L <0.0080 n (dissolved) mg/L <0.0080 n (dissolved) mg/L <0.0080		6.92 -199 301 1.37	7.07 -179 281	9.00	79.63	98.45		
mv -71.5 ecific Conductivity emhos 139.6 solved Oxygen mg/L 0.52 mperature °C 16.5 nd Iron (dissolved) mg/L 2.73 Id Iron (total) mg/L 3.05 rbidity NTU 0.68 rminum dissolved mg/L <0.10 senic dissolved mg/L <0.0080 senic total mg/L <0.0080 n (dissolved) mg/L <0.0080 n (dissolved) mg/L <0.0080	6 4 8 6 1.01.01.01	-199 301 1.37	-179 281	6.81	6.71	6.71	6.5 - 8.5	
emhos 139.6 mg/L 0.52 c 16.5 mg/L 2.73 mg/L 3.05 NTU 0.68 mg/L <0.10 mg/L <0.10 mg/L <0.10 mg/L <0.10 mg/L <0.10		301 1.37 14.2	281	53	96	26		
mg/L 0.52 oC 16.5 mg/L 2.73 mg/L 3.05 mg/L <0.08 mg/L <0.10 mg/L <0.10 mg/L <0.10 mg/L <0.10 mg/L <0.10		1.37		275	254	215		
°C 16.5 mg/L 2.73 mg/L 3.05 mg/L <0.10 mg/L <0.10 mg/L <0.10 mg/L <0.0080 mg/L <0.0080 mg/L <0.0080		14.2	0.83	0.53	0.47	0.44		
mg/L 2.73 mg/L 3.05 NTU 0.68 mg/L <0.10 mg/L <0.10 mg/L - mg/L - mg/L - mg/L - mg/L - mg/L 3.1			15.5	16.4	16.5	16.7		
mg/L 3.05 NTU 0.68 mg/L <0.10 mg/L <0.10 mg/L - mg/L - mg/L - mg/L - 3.1		0.07	0.04	0.05	0.07	0.09	0.3	
NTU 0.68 mg/L <0.10 mg/L <0.10 mg/L - mg/L - mg/L - mg/L 3.1		0.12	0.08	0.11	0.22	0.15	0.3	
mg/L <0.10 mg/L <0.10 mg/L - mg/L - mg/L <0.0080		1.31	0.74	0.53	0.63	1.22		
mg/L <0.10 mg/L - mg/L <0.0080		0.03		<0.001	0.014	<0.001	0.2	200.7
ed mg/L - mg/L - 60.0080) mg/L 3.1		<0.10	<0.001	<0.001	0.047	0.025	0.2	200.7
mg/L. <0.0080 mg/L 3.1		<0.001		<0.001	0.0011	<0.001	900.0	200.9
mg/L 3.1	<0.0030	<0.001	<0.001	<0.001	<0.001	0.0012	9000	200.9
	<0.10	<0.1	<0.1	<0.1	* 0.1	40.1	0.3	200.7
Iron (total) mg/L 3.0 <0.10	<0.10	<0.1	1.0>	<0.1	0.1	0.12	0.3	200.7
e dissolved	<0.015	0.014		0.044	0.047	0.043	90.02	200.7
Manganese total mg/L 0.048 <0.015		0.015	0.028	0.045	0.048	0.037	0.05	200.7
	æ. 1.	6.6	9.6	8.8	7.8	5.8		200.7
	13	F	7	7-	9.4	7.3		200.7

TABLE 3
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-3

Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery 3	Recovery 4	Recovery 5	Federal Drinking Water Standards	EPA Standard Testing Method
Percent recharge recovered Constituent	Units			16.05	43.78	59.08	79.63	98.45		
Sodium total	mg/L	20	41	18	17	18	20	21	20	200.7
Calcium total	mg/L	8.7	38	36	27	25	22	18		200.7
Sulfate	mg/L	0.9	22	42	39	34	31	23	250	300.0
Chloride	mg/L	7.07	09	61	55	53	47	35	250	300.0
Alkalinity	mg/L	6.69	53	56	46	42	45	49		2320B
Phosphate	mg/L		<0.75	<0.75	<0.75	<0.75	<0.75	<0.75		300.0
Nitrate	mg/L	<0.50	1.5	<0.50	<0.50	<0.50	<0.50	<0.50	10	300.0
Fluoride	mg/L		0.92	29.0	0.58	0.49	0.42	0.58		
Silica	mg/L	ŧ	&	7	7	9	7	9		370.1
Dissolved organic carbon	mg/L	ı								
Total organic carbon	mg/L	<1.0	4.0	1 .5	6.7	1.2	1.3	1.0		415.1
Total dissolved solids	mg/L	ı	240	210	190	190	193	197	200	2540C
Total suspended solids	mg/L		<5.0	<5.0	<5.0	<5.0	<5.0	5.0		160.2
Hardness	mg/L		130	40	100	100	87	69		
Chloroform	ng/L	<0.50	26	22	5.1	2.1	1.2	0.74		524.2
Bromoform	ng/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50		524.2
Bromodichloromethane	ng/L	<0.50	7.4	3.1	0.55	<0.50	<0.50	<0.50		524.2
Dibromochloromethane	ng/L	<0.50	<0.50	0.51	<0.50	<0.50	<0.50	<0.50		524.2

TABLE 3
Summary of Field and Laboratory Water Quality Test Results
ASR-1 During Test Cycle-3

Sample		ASR-1 Native Ground Water	Recharge Water	Recovery 1	Recovery 2	Recovery F	Recovery F	Recovery 5	Federal Drinking Water Standards	EPA Standard Testing Method
Percent recharge recovered Constituent	Units			16.05	43.78	59.08	79.63	98.45		
Gross Alpha	pCi/L	1		3.67			3.93		ئ	NJAC 7:18-6
Gross Beta	pCi/L	•								
Radium-228	pCi/L			<0.790			<2.59		S	904.0
Radium-226	pCi/L	•		<0.425			<0.514		5	903.1

*Adjusted with KOH

Figure 2
Construction Diagram for ASR-1
United Water Delaware
Saint George's Crossing

CH2MHILI

MAPS

SEE ORIGINALS INDOCKET

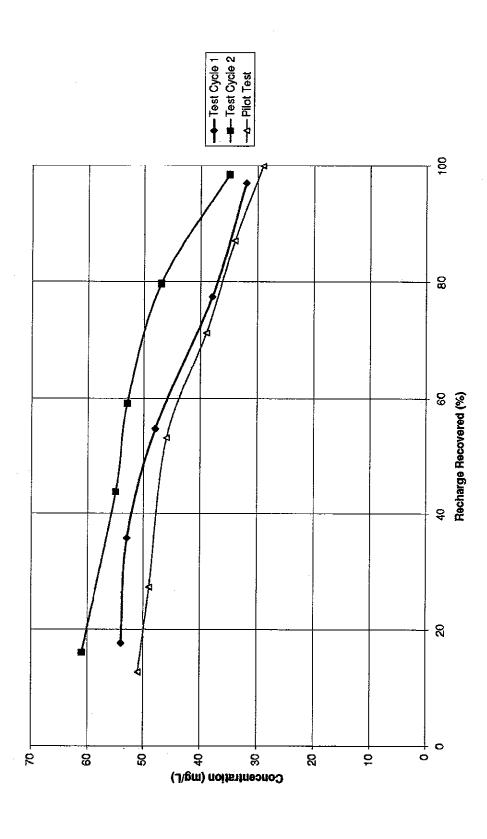


Figure 4
Chlorides in Recovered Wate for Test Cycles 1 through 3
United Water Delaware
Sant George's Crossing

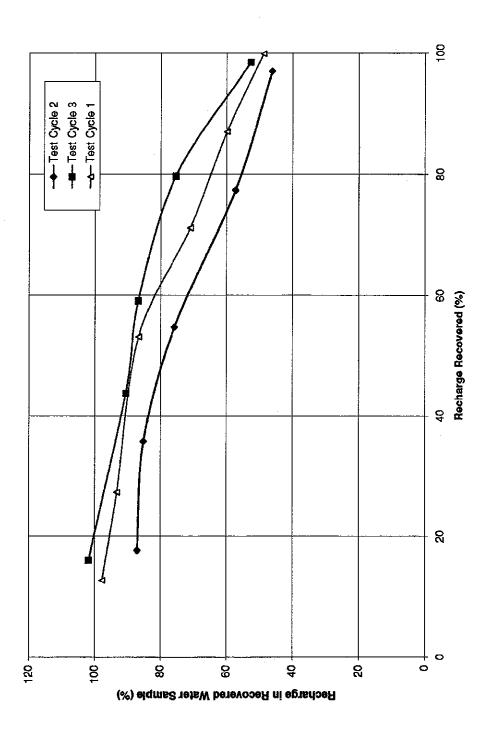


Figure 6
Total Iron in Recovered Water for Test Cycles 1 through 3
United Water Delaware
Saint George's Crossing

Direct Oxidation at Iron Mineral Surface

1265_161679.dgn

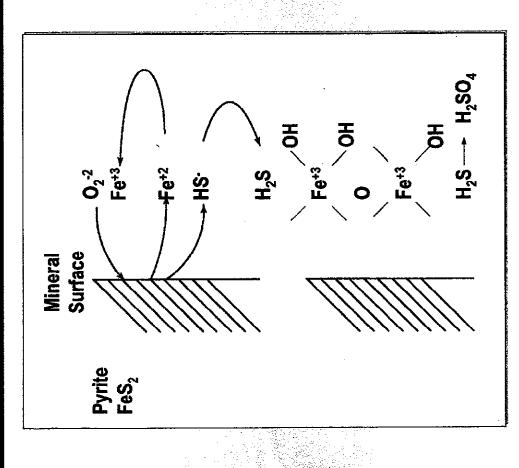
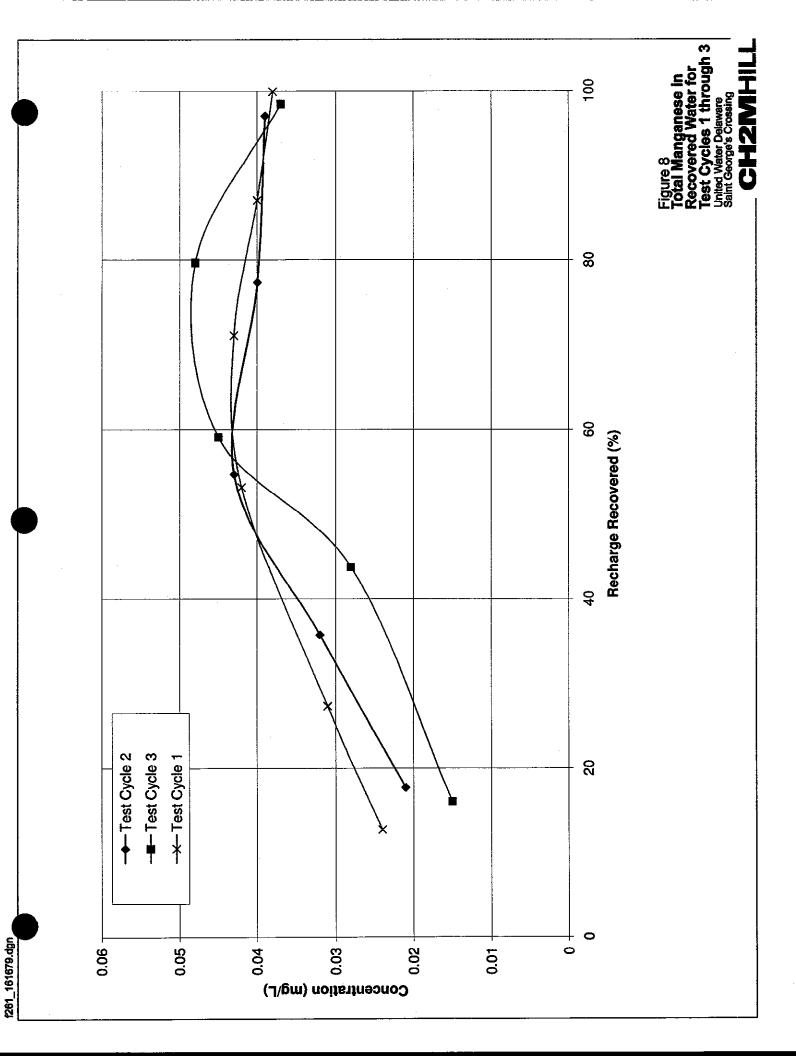


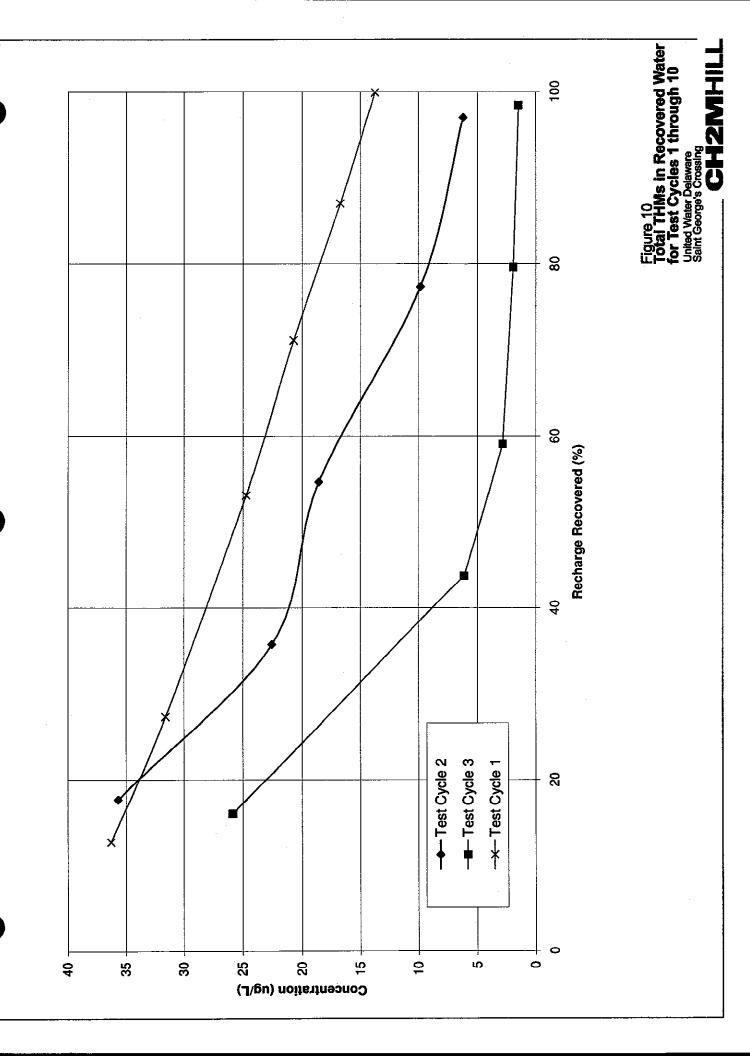
Figure 7

Conceptual Diagram of Passivation of Pyrite
United Water Delaware
Saint George's Crossing

CHASHIE CHASHIE



CH2MHIL



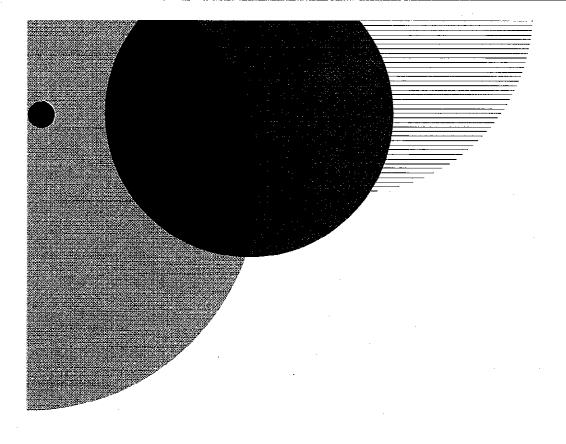
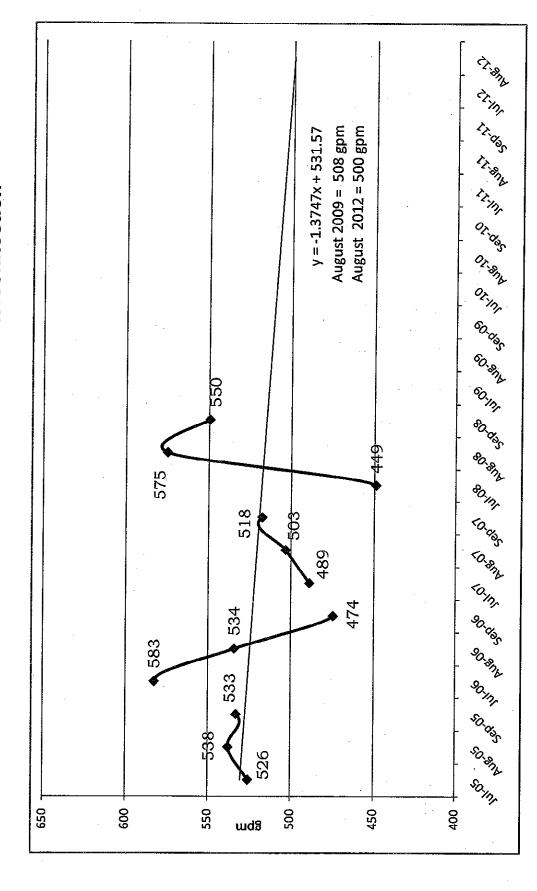


Exhibit 3

United Water Delaware/ United Water Bethel State Line Flow Trend



UWDE/UWBethel State Line Interconnection



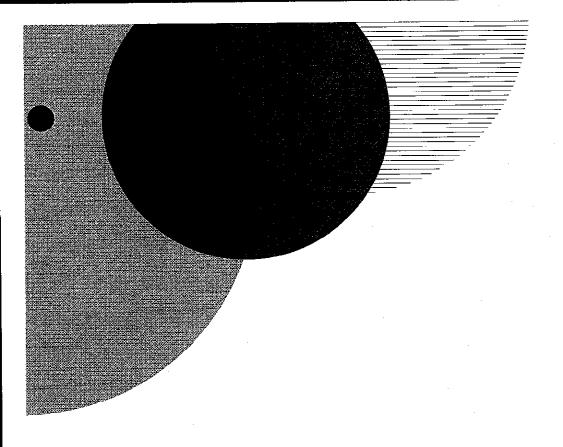


Exhibit 4 Governor Printz and Concord Square Interconnection Engineer's Report



UNITED WATER DELAWARE 2000 FIRST STATE BLVD. WILMINGTON, DE 19804 TEL 302-252-3016 FAX 302-633-5919 ted.harris@unitedwater.com United Water

TO: Nancy Trushell FROM: Ted Harris DATE: 5/22/09 PAGES: 1

SUBJECT: City of Wilm Interconnection at Gov. Printz Blvd.

MEMO

On the afternoon of May 12, 2009, a flow test was performed on the City of Wilmington interconnection at 3806 Gov Printz Blvd. This one-way interconnection from the City to United was installed in 1979. A 12" DI city main feeds a 6'x10'concrete meter pit containing 6" pipe and appurtenances (meter, backflow preventer, and butterfly valve). Documentation from City Work Order #65891 indicates that the pit is owned and maintained by the City. Overall the pit seems to be in decent condition. United Water's responsibility begins directly on the discharge side of the pit where the line increases from 6" to 12". This 12" main then continues approximately 180' before teeing into our 20" transmission main near Edgemoor Resevoir.

Since this interconnection had not been used in at least 20 years, a flow test was needed in order to confirm its capabilities. After planning and discussions with the City, a test was scheduled for 5/12/09. It was determined that the pit was live; no valves needed to be turned on the city's side to supply the pit. United valve #33-49 is the only valve that needs to be opened to activate the interconnection. Test results and conditions were as follows.

Gov Printz Interconnection flow rate = 1100 gpm

System Conditions during test:

Stanton HS Pumps #3&5 on (flow split between north and south systems); Edgemoor Reservoir level approximatly 12' (gauge broken, determined by visual inspection); Edgemoor Reservoir 24" bypass valve closed, 8" regulating valve fully open; Edgemoor Booster Pump #1 on; City static pressure at pit 52 psi; City residual pressure at pit 33 psi.

Please let me know if you have any questions.



UNITED WATER DELAWARE 2000 FIRST STATE BLVD. WILMINGTON, DE 19804 TEL 302-252-3016 FAX 302-633-5919 ted.harris@unitedwater.com



TO: Nancy Trushell FROM: Ted Harris DATE: 5/22/09 PAGES: 1

SUBJECT: City of Wilm Interconnection at Concord Square

MEMO

The Concord Square interconnection, located at the Concord Square Shopping Center along Rt 202 just north of Silverside Road, was constructed at the end of 2008. Since the City's and United's pressures are nearly identical in this area, the interconnection would function by closing valve #11-4 and isolating our service area along Rt 202 south of Concord Mall. The new interconnection valve at the pit would then be opened, allowing the City to supply these customers. Billing records indicate an average demand of approximately 100 gpm to these customers. The interconnection was sized to also meet fire flow demand if needed.

Please let me know if you have any questions.



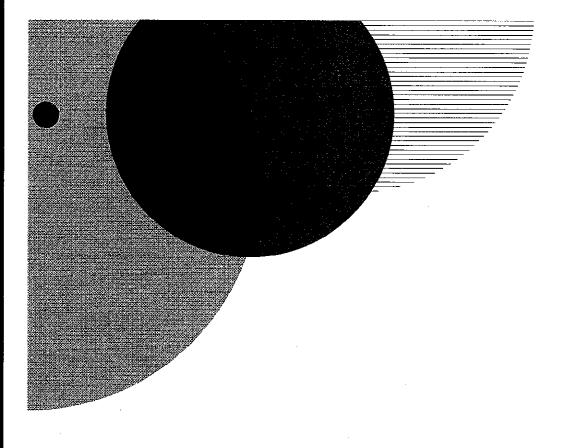


Exhibit 5 Consumer Water Conservation Plan 2009-2012





UNITED WATER DELAWAREConsumer Water Conservation Plan 2009-2012

July 1, 2009



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INTRODUCTION

Conservation is a focal point at United Water Delaware (UWDE). The UWDE website, inserts in the News Journal, the annual ET Index lawn water conservation education program, Rain Garden, EPA WaterSense partnership, conservation education billing inserts, plant tours, conservation messaging on door hangers, and residential conservation rate structure are some of the ways that United Water currently promotes conservation awareness in the communities that it serves.

This Consumer Water Conservation Plan (CWCP) will describe the current practices in our organization which include added measures that have been taken to continue and enhance consumer awareness of, and encourage our customers' participation in, water conservation practices and behaviors. The summary below highlights the programs, services, and practices that are currently in place at United Water, with a summary of planned efforts for the future:

- Water Conservation Rates
- Annual Conservation Guide
- **ET Index Lawn Watering Conservation Education Program**
- Rain Garden and Conservation landscape Design at UWDE Office
- Water Saver Kits and leak detection tablets
- Public Awareness and Communication
- Water Treatment Plant tours and Speaker's Bureau (Education)
- Water Services Field Service and Home Services
- System Leak Detection

Some of the programs and services currently at United Water Delaware have been in place for a number of years, others are fulfillments of commitments made in our 2006-2009 Consumer Water Conservation Plan, while others reach beyond either category.

As we stated in our 2006-2009 CWCP, our direction for the future is to be the example, raise awareness of conservation, step up our conservation communications, and take our place as a strong contributing asset to our community.

Programs that we have implemented in this regard include:

- + Installation of a rain garden at the Customer Service Office
- Planting of drought resistant landscaping and promotion of this practice
- Increased communication with customers
- Heightened public presence
- Installation of an evapotranspiration weather station and accompanying lawn watering conservation education program



Conservation must be a part of our every day routine. Over the years, United Water Delaware has developed a good foundation in promoting conservation. Communication is a crucial piece of any successful plan. Our goal, as a water utility, is to go from awareness to participation, information to practice, and from reactive to proactive.

WATER CONSERVATION RATES

Water conservation rates have been in effect at United Water Delaware since January 1, 2005. Since then, residential customers have been billed using an inclining block rate.

The residential rate structure in place today more vigorously promotes conservation by increasing the unit price (per thousand) of water as usage increases. Therefore, the more consumption used by a customer, the more costly the charge will be. The inclining block conservation rate implemented in 2005 was designed to promote the monetary value of conservation and to be revenue neutral for United Water Delaware. Since that time UWDE had a rate increase in January 2007 as well as Interim Rates Under Bond in effect since April 14, 2009.

The following table illustrates UWDE's rates under bond that became effective in April 2009. The percentage increase in rates between the rate steps continues to take a serious approach as the cost of the water increases dramatically as customers use more. This level of increasing difference in the price per thousand gallons between rate steps further encourages conservation as customers who conserve water and reduce their usage will, in turn, save more money.

Current Quarterly Residential Conservation Rate Step Comparison

<u>Consumption</u>	Bonded Rates	% of Difference
0 - 5,000	\$3.1108	
5,001 - 20,000	\$3.7051	+19%
Over 20,000	\$5.2264	+41%

WATER SAVING DEVICES

WATER SAVER KITS

United Water has expanded, enhanced and broadened the reach of its effort to provide customers with water saving devices for both inside and outside the home. United Water has partnered with a major distributer of water saving conservation kits, Niagara Conservation, offering home conservation kits at drastically reduced prices, primarily



through our website, but also through a mail-in coupon program. This program offers home conservation kits regularly retailing for \$30.00, \$40.00 and \$65.00 for \$5.00, \$7.00, and \$15.00 respectively.

The kits are a great addition to the conservation-conscious household. The selection of conservation kits contain the following items:

Standard Water-Saving Kit

- 2 showerheads
- ♦ 1 kitchen aerator
- ♦ 2 bathroom aerators
- ♦ 2 toilet tank banks
- ♦ 2 dye tablet packs
- ◆ 1 shower coach (timer)

Outdoor Landscape Kit

- 1 water miser garden hose nozzle
- 1 automatic sprinkler timer
- 3 rain gauges
- ♦ 1 moisture meter
- 3 hose repair kits

Deluxe Water-Saving Kit

- ◆ 1 showerhead
- 1 handheld massage showerhead
- 3 bathroom aerators
- ♦ 1 kitchen aerator
- ♦ 3 toilet tank banks
- ♦ 3 dye tablet packs
- ♦ 1 shower coach
- ◆ 1 roll Teflon antileak tape

The indoor leak detection kits provide customers with instructions on checking their home for toilet leaks which can waste 100 gallons of water a day. As an additional motivational tool, information is included that translates what water conservation can mean in dollars and cents. Stopping common leaks may reward customers with as much as \$100 a year in water bill savings.

The water faucet aerator included in the water saver kit reduces flow from the faucet by two gallons a minute. This can cut the average usage from that faucet in half. The use of the water faucet aerator can also save energy by reducing the amount of hot water used.

The toilet tank bank is a bag that is filled with water and then placed in the toilet tank. The tank bank displaces water in the tank so that when the tank refills, it reduces the number of gallons of water that are used per flush.

These water saver kits help customers conserve water and energy, which provides them with savings on their water, electric or gas bills. Over 300 water saver kits have been ordered since the inception of this United Water conservation program in 2007.



LEAK DETECTION TABLETS

As part of United Water Delaware's efforts to provide customers with water conservation solutions, our Customer Service Center offers leak detection tablets to walk-in customers. Leak detection tablets are also among the water conservation items and information provided by our volunteers who staff the United Water booth at public events. Placing tools they can use to conserve into the hands of customers allows them to proactively practice water saving behavior.

PUBLIC AWARENESS AND COMMUNICATION

CONSERVATION GUIDE

Water is our most precious natural resource and United Water Delaware provides important information each year on wise water use to thousands of area residents with our Annual Conservation Guide. This informative tabloid style publication, which United Water developed, contains articles, information, contacts and tips on how we all can best use water wisely.

Initiated in 2007, the Annual United Water Conservation Guide reaches approximately 50 thousand local residents as an insert in the News Journal newspaper in the late May or early June timeframe. We focus dissemination on the zip codes in which our customers reside. Copies have also been made available to local horticultural and nature organizations as well as schools and youth groups. In addition, our outreach brings the Conservation Guide into the community at special events and it is included among the take home items given to students who join us for educational tours at our Stanton Water Treatment Plant. The public may also pick up a copy at our Customer Service Center located at 2000 First State Boulevard.

The Annual Conservation Guide also serves as an important cross-promotional tool for a number of United Water sponsored conservation programs, leveraging greater value and taking conservation promotion to the next level and beyond a customers' billing envelope. The Guide raises conservation awareness, informing and reminding residents of the myriad methods by which they can get involved in saving water. Our ET Index lawn watering conservation education program, the availability of water saving devices, native plant species use and other water wise measures are among the measures promoted in the Guide.

BILL INSERTS

Recognizing the cost effectiveness of the billing envelope as a delivery method, United Water Delaware continues to provide a number of billing inserts with conservation topics to customers. United Water Delaware met or exceeded commitments articulated in the 2006-2009 CWCP in this regard. Our spring water-wisely insert provides indoor and outdoor water saving information, instructs customers on the financial and energy saving



nature of water conservation as well as its potential reduction in greenhouse gas emissions. In addition, United Water bill inserts educate and inform customers on techniques and actions they can take to prevent the damaging effects and unnecessary water losses stemming from frozen pipes.

In 2008, United Water Delaware also accompanied customers' bills with an insert promoting the company's new eBilling or paperless billing option. Increases in the number of customers who "go paperless" with eBilling translate into increased conservation of resources. It is estimated that if all United Water customers nationwide went paperless with eBilling, 2 million gallons of water and 239 tons of trees could be saved annually, while greenhouse gas emissions would be reduced by 600,000 pounds.

DOOR HANGERS AS CONSERVATION MESSAGE DELIVERY VEHICLES

Each day, United Water Delaware Field Service and Transmission and Distribution employees "make house calls" concerning a broad spectrum of issues related to water service. They are now also delivering water conservation information to hundreds of customers each year. Valuable information has been added to the previously blank, reverse side of a variety of notices that are routinely hung by hand on customers' doors throughout the year to inform them of issues impacting their water service. Door hanger conservation messaging includes information on where most water is used in the home and provides techniques on how customers can reduce their water use.

BILLING INFORMATION

A global re-design of our billing statement enables United Water Delaware to provide customers with tools to better track and compare their water consumption. Providing this comparative information encourages customers to conserve by allowing them to see for themselves the water and money savings that result from their own conservation efforts.

WEBSITE

United Water launched a new, interactive, content rich website, with increased availability of conservation information. When customers go to this new, website, www.unitedwater.com, they type in the zip code where they live and they are able to access and browse an excellent source of conservation information and resources including water conservation related videos, text and links.

Among the valuable links available in the United Water conservation section is one giving customers access to the US Environmental Protection Agency (EPA) WaterSense website http://www.epa.gov/WaterSense/pubs/res.htm. United Water has joined with the EPA as a partner in its WaterSense conservation program that is focused on the value of water. Among the wide ranging conservation information and techniques provided within WaterSense, consumers are encouraged to seek out water saving appliances that bear the WaterSense label. Similar to the EnergySaver appliance labeling program, WaterSense helps inform customers of the value if choosing water saving appliances.



The United Water website also provides customer access to the daily ET Index number, telling them how much and when they need to water their lawns during the growing season May-September. United water's website links to this lawn watering conservation education program at http://www.sjrcd.org/public/wilde.html.

Community Partnerships

United Water Delaware promotes and encourages water conservation through its partnerships with long standing and well recognized non-profit, environmental organizations and volunteer groups whose missions focus on protecting, preserving and improving local water resources. In partnership with the Delaware Nature Society, United Water Delaware's "ET Index" lawn watering conservation program is available daily during link on the Delaware Nature Society website via season http://www.delawarenaturesociety.org/conservation.html. Broadening the reach of United Water Delaware conservation programs in this manner provides cost effective and efficient results, tapping into an audience of environmentally conscious consumers.

United Water Delaware also partners with and volunteers on the Board of the Red Clay Valley Association, the second oldest small watershed association in America, founded in 1952. Promoting and practicing water conservation are among the myriad tasks carried out by the RCVA through its 700 members. United Water's partnership with the White Clay Creek Wild and Scenic Program has helped promote rain barrel use as a means of water conservation along with increasing awareness of how native species plantings save water. United Water has helped fund efforts by the Partnership for the Delaware Estuary to educate teachers from across the state about the importance of conservation and protection of our precious water resources.

PUBLIC EVENTS

The message of conservation is also a part of the display theme that United Water Delaware uses in community events such as the Harvest Moon Festival at Ashland Nature Center, Green Day in Claymont and White Clay Creek Fest outside Newark. UWDE has brochures available to educate customers about water conservation, its ET Index lawn watering education program, the importance of watershed protection, water wise gardening, the availability of water saving kits, and conservation facts about water. Our staff is also available at these functions to answer questions and offer information. In the years 2006-2009, United Water's conservation community outreach included public events attended by over 16,000 members of the community.

Enviroscape

To attract and educate young visitors at our public event booth, United Water Delaware uses a state of the art educational tool called Enviroscape. This portable, table-top model provides a unique, interactive learning experience geared towards our youngest members of society. Enviroscape makes the connection between what we do on earth and environmental quality. It crosses cultural, learning and age levels, helping people see how



they can make a difference. United Water's Enviroscape focuses on drinking water sources and treatment as well as having a wastewater component.

PLANT TOURS / SPEAKER BUREAU (EDUCATION)

We offer tours of the treatment plant facility as well as employee speakers that are available to visit organizations and schools to talk about water. Schools and organizations contact us for a speaker or to set up a tour of the Stanton Water Treatment Plant Facility. United water provides plant tours as an important educational opportunity for the community. Our treatment plant tours provide a first hand, educational experience for tour participants, focusing on what it takes to produce drinking water and further increasing their understanding of its value.

To maximize positive benefit, we have refined our plant tours, targeting educational efforts on participants at the fifth grade level and above. Enhanced comprehension, retention, and translation into conservation action are goals of this approach. United Water Delaware has also developed graphics and text for distribution to students in their classrooms, prior to their tours, to enhance and engage their understanding of the process and its importance. This effort enhances potential for greater comprehension and retention of information presented while on-site. Approximately 500 members of the community participated in this conservation educational effort from 2006-2009.

SERVICES

INTERNAL SERVICE LINES

The Field Service and Transmission and Distribution Departments at United Water Delaware are available to check on leaks that are called in by customers who have reported a leak in a main, a hydrant, service line, or inside their home. This service continues to help the customer identify if there is a problem so that it can be repaired in a timely manner and minimize the amount of water that is lost to a leak.

HOME SERVICES/LEAK GUARD

Home Services has been offering its service line plan and internal plumbing service programs to our customers through direct marketing campaigns with our branding. We have included their website link on our own site as well for the convenience and ease of obtaining information about the company and their services in order to assist customers with making an informed decision and easily obtaining contact information for Home Services. As of June 2009, 7,658 United Water Delaware customers have at least one contract with Home Services.

The programs offered do offer peace of mind to our customers when faced with a leak repair or water emergency in the home that may have been too costly to rectify



immediately. Our customers can have leaks repaired quickly which contributes to the conservation of water.

System Leak Detection/Unaccounted For Water

United Water Delaware is focusing inwardly as well, in its efforts to accomplish meaningful water conservation. Investments are being made in human, mechanical and technological resources to better pinpoint, track and conserve the drinking water we produce. Expanded engineering expertise is being brought to bear on reduction of water losses in our more than 500 mile delivery system. Staff has also been added within our Transmission and Distribution Department (T&D) to more effectively perform routine leak detection audits. Technology, including GIS, sub-surface acoustical leak detection devices, and computerized correlation technology is being employed.

New and more accurate metering is being installed both at our Stanton Water Treatment Plant and out in our transmission and distribution system. Long range planning and execution is underway, focusing on critical sections of our large transmission water mains, the backbone of United Water's delivery system.

LEADING BY EXAMPLE

CONSERVATION LANDSCAPE DESIGN

United Water Delaware is leading by example, having instituted principles of low-water, conservation landscape design at our Stanton facilities. Non-native species landscaping plantings have been replaced with native species plants. This landscaping approach requires less water and has been used as a public educational tool in our annual Conservation Guide. By employing this approach at our facilities, United Water Delaware is not only saving water itself but also educating and encouraging others to do the same.

Rain Garden

United Water Delaware has invested in the planning, construction, and promotion of a rain garden at our main facilities in Stanton. Rain gardens are designed to capture storm water run-off from buildings and other sources and allow it to naturally percolate back into the ground, recharging supplies. Storm water run-off can cause numerous problems, from pollution of our waterways to flooding. The rain garden is a natural approach to helping reduce storm water run-off issues. Rain garden plants are also native species and possess the ability to withstand seasonal fluctuations in precipitation. In addition they are specifically selected for their ability to thrive in a periodically semi-submerged growing environment. Replacing lawn turf with a rain garden also reduces outdoor watering demands during peak water use seasons.

Examples of native species plants for this region are provided for the public in our Annual Conservation Guide.



The plants included in the United Water Rain Garden include:

- Athyrim filix-femina (Lady Fern)
- Chelone glabra (White Turtlehead)
- Clethra alnifolia 'Hummingbird' (Dwarf Summersweet)
- Eupatorium dubium (Three-nerved Joe Pye Weed)
- Ilex verticillata 'Winter Red' (Winterberry)
- Itea virginica "Little Henry' (Dwarf Virginia Sweetspire)
- Iris versicolor (Blue Flag Iris)
- Juncus effusus (Soft Rush)
- Lobelia cardinalis (Cardinal Flower)
- Osmunda cinnamomea (Cinnamon Fern)
- Senicio aureus (Golden Ragwort)

United Water Delaware has provided customers with a "How-To" primer on building their own rain garden in our Annual Conservation Guide as well as providing contact information and links to local nature and horticultural organizations for more detailed information. In 2008, the United Water rain garden was included in a statewide water educational program sponsored by the Delaware Nature Society and the Water Resources Agency at the University of Delaware. The sponsors used a scavenger hunt approach to water education. Participating teams came to United Water Delaware's Stanton facility, gathered the name of a plant in the rain garden and a copy of United Water Delaware's Annual Conservation Guide. We anticipate continued future participation in this water educational effort.

EVAPOTRANSPIRATION WEATHER STATION

This project provides the public with science based information to reduce excessive summertime lawn watering. The evapotranspiration or "ET" program is conducted in partnership with a branch of the U.S. Department of Agriculture. A research grade weather station at our Stanton Water Treatment Plant compiles weather and water data during the growing season and translates the information into an accurate method for telling customers how much and when they actually need to water their lawns. Each day the "ET Number" is posted on the United Water website and is available on the "ET Hotline at 302-252-3054. It is an excellent resource for homeowners to use in determining when it is appropriate to water so that their lawn watering time is done only when it is really needed. The availability of this kind of information can play a key role in conservation. Our customers are able to gauge the water needs of their lawn as often as on a daily basis. In its first two years of operation, approximately 2,700 people have accessed the daily ET number either on the web or by phone.

PROGRAM MONITORING

United Water Delaware is committed to conservation. We remain on schedule to the timetable for our projects, events, written communication and technological enhancements. We went above and beyond the expectations of our own plan with the



addition of community events, the improvements to the website, the inclusion of the eBill program and the Annual Conservation Guide.

We have added to our timetable as outlined below for this plan. We will continue our commitment to our customers and to conservation. Communications remain the main tool in our program. Our Conservation plan communicates with our direct and indirect customers, children and young adults, as well as members of our community that are not United Water customers. We have continued with written communications vehicles and have enhanced our communications and services to meet with current technology. Our plan reaches out in all directions in a number of different ways to get the conservation message out and in educating customers on ways to put it into practice.

CONSUMER WATER CONSERVATION PLAN ACTION TIMELINE

L	INITED	WATE	R DELA	WARE	CONS	ERVAT	ION PL	AN					
	2010 2011									2012			
PROJECT	1ST	2ND	3RD	4TH	1ST	2ND	3RD	4TH	1ST	2ND	3RD	4TH	
Conservation Guide		X		÷		x				X			
Bill Inserts		X	-	X		X		Х		X		X	
Website	x	X	X	X	x	X	X	X	х	X	X	X	
Tours/Speakers (as scheduled)	x	X	X	Х	х	X	Х	Х	х	X	X	X	
Rain Garden	х	X	· X	X	x	X	X	X	Х	X	X	X	
Leak Detection	x	X	X	X	Х	X	X	X	x	X	X	X	
Garden Promotion		X				X				X			
ET Program		Х	X			X	Х			X	х		
Consumption Monitoring	x	X	X	х	X	Х	X	X	x	Х	X	X	

EFFECTIVENESS OF THE CONSUMER WATER CONSERVATION PLAN

United Water has compiled and analyzed water consumption data as part of its effort to evaluate the effectiveness of its water conservation plan. It should be noted that numerous variables make it difficult to accurately pinpoint specific cause and effect relationships when evaluating effectiveness of elements within consumer water conservation plans. Variables impacting household water use range from environmental changes (annual precipitation and temperature differences) and to human changes (the number of household occupants grows or shrinks – babies born, children grow up and move out etc.) Both have major impacts on water usage.

Additionally, while education that leads to behavior modification is the goal, there is not a guaranteed result. In 1996, the University of Delaware, College of Urban Affairs and Public Policy reported, "While the impact of public education is difficult to measure

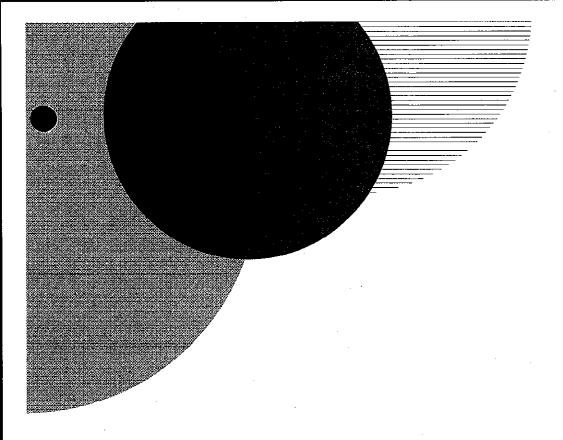


quantitatively, education is often viewed as key to water conservation." One can however observe trends that emerge based on consumption data analysis. Two cases in point are illustrated here.

The first is a comparison of average residential customers' water consumption, before and after the conservation plan's implementation. In the full calendar year prior to United Water's implementation of the 2006-2009 conservation plan, the average residential customer was consuming 167 gallons per day and at the end of the plan's last full year, consumption had dropped to 160 gallons per day. For data that supports this, refer to Appendix A. This reduction in gallons per day could equate to nearly a quarter of a million gallons (224,000 gallons per day for our residential customer base).

In addition, UWDE compiled before and after usage data on a sample group of residential customers who ordered home water conservation kits as a result of United Water's conservation program. Since 2007 and through May 2009, a total of 321 conservation kits have been purchased either through our website or by coupon. An analysis of a sample of those customers who purchased conservation kits through United Water shows an average annual reduction in water use of 2,200 gallons per customer. For information regarding this, refer to details in Appendix B.

For each year of the 2006-2009 conservation plan, United Water also has assembled annual timelines that bring together water usage information and delivery timing of the many differing conservation plan elements within the plan. For additional details regarding this data, please refer to Appendix C.

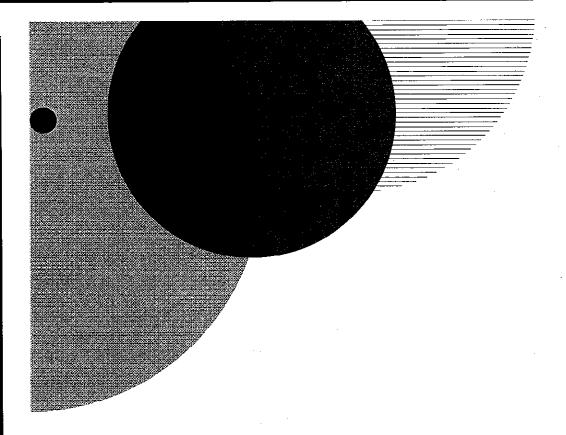


Appendix A Annual Residential Consumption



UNITED WATER DELAWARE ANNUAL RESIDENTIAL CONSUMPTION (BILLED QUARTERLY)

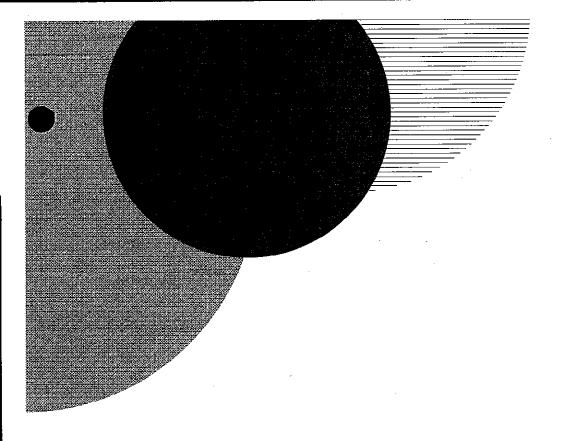
	INITO AL INLOIDLINI	WIE COMOUNT IT	ON (DILLED GOAR IE	111
	ANNUAL	# OF CUSTOMERS	AVERAGE CONSUMPTION PER	
YEAR	CONSUMPTION	BILLED	CUSTOMER	VARIANCE
2004	1,939,451	131,872	14.71	
2005	2,046,267	135,762	15.07	2.48%
2006	2,008,466	132,443	15.16	0.61%
2007	2,031,347	139,816	14.53	-4.19%
2008	1,976,922	137,314	14.40	-0.91%
2009*	721,486	56,161	12.85	-10.77%
* FIGURE	S ARE THROUGH MOI	NTH END MAY 2009		



Appendix B Consumption History Conservation Kits Purchased



CONSUMPTION HISTORY OF UWDE CUSTOMERS WHO PURCHASED CONSERVATION KITS IN JUNE 2007	MERS WHO PURCHASED CONSE	1 1:	VARIANCE
Jul-08	MAY 2006 TO MAY 2008		A AINANICE
UMPTION PER QUARTER	19.11	17.50	-1.61
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
30-Inf	JUNE 2007 TO JUNE 08	SEPT 08 TO MAR 09	
AVERAGE CONSUMPTION PER QUARTER	14.25	12.67	-1.58
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
Jul-08	JUNE 2006 TO JUNE 2008	SEPT 2008 TO MAR 2009	
UMPTION PER QUARTER	11.67	15.67	4.00
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
nl-08	JULY 2006 TO JULY 2008	OCT 2008 TO APRIL 2009	
UMPTION PER QUARTER	17.44	6.67	-10.77
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
Jul-08	MAY 2006 TO MAY 2008	AUG 2008 TO MAY 2009	
UMPTION PER QUARTER	13.78	11.50	-2.28
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
Jul-08	JULY 2006 TO JULY 2008	OCT 2008 TO APRIL 2009	
UMPTION PER QUARTER	14.11	10.33	-3.78
DATE OF PURCHASE	CONSUMPTION BEFORE	CONSUMPTION AFTER	VARIANCE
Jul-08	May 2006 to May 2008	Aug 2008 to May 2009	-
AVERAGE CONSUMPTION PER QUARTER	16.44	17.75	1.31
ONSUMPTION FOR THE GROUP	10680	92,09	-14.71
CONCINE	SNOTING TO THE STATE OF THE STA	3	
TONOCHOO	וו וו ווו ווו ווו ווו ווו ווו ווו ווו	2	



Appendix C Residential Consumption



UNITED WATER DELAWARE RESIDENTIAL CONSUMPTION 2006

CONSERVATION ET	GUIDE INDEX EVENTS				×					×				
CON				-						×	×	×	×	
	BILL MESSAGE SAVER KITS								:					
	VARIANCE BILL INSERT F										X	×	×	
	VARIANCE		1.20	(4.57)	1.66	(3.79)	(0.22)	(80.0)	0.79	5.89	(2.62)	12.61	(2.23)	60 0
	CONS PER CUST	18.69	16.27	10.50	16.73	11.28	14.85	14.99	15.86	20.96	12.45	27.68	12.84	15.16
	# CUST	9,302	8,926	15,433	9,713	12,259	11,648	12,235	10,131	9,580	14,587	5,924	12,705	132,443
	CONSUMPTION	173,847	145,246	162,016	162,461	138,289	172,956	183,394	160,724	200,797	181,677	163,989	163,070	2 008 466
	MONTH	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	\JOL \	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTALS

UNITED WATER DELAWARE RESIDENTIAL CONSUMPTION 2007

CONSERVATION ET	JANCE BILL INSERT BILL MESSAGE SAVER KITS GUIDE INDEX EVENTS	.11) x	× 25	x (48.	X / X / Z	X X (96:	X X X (45.5)	.83) x X × (83)	34 X X X	X X X X 22 12 22 22 22 22 22 22 22 22 22 22 22	X 88	x 96	. 14) x	
	CONS PER CUST VARIANCE BILL INSERT E	11.96 (3.11)	19.64 4.57	14.23 (0.84)	17.14 2.07 🗶	9.11 (5.96) X =	13.73 (1.34) X	14.24 (0.83)	15.41 0.34 🛣 🗶 📉	18.64 3.57 X X 7 X	18.95 3.88 X X X X X X X X X X X X X X X X X X	16.02 0.95	11.93 (3.14)	14 60
-	CONSUMPTION # CUST CONS	180,641 15,110	138,500 7,052	163,804 11,513	167,618 9,777	145,593 15,982	163,788 11,927	173,274 12,164	156,296 10,140	200,724 10,768	207,201 10,936	165,665 10,343	168,243 14,104	210001 7101000
	MONTH CONSI	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	O IVIUL

Consumption is in thousands of gallons

UNITED WATER DELAWARE
RESIDENTIAL CONSUMPTION 2008

		INDEX EVENTS				×		×		×	×				
	Ш	NDEX					×	×	×	×					
	CONSERVATION	GUIDE						×							
		SAVER KITS	×	×	×	×	×	×	×	×	×	×	×	×	
ION 2008		BILL MESSAGE	X	×	-				×	X					
RESIDENTIAL CONSUMPTION 2008		VARIANCE BILL INSERT				×	×	×				X	×	X	
AESIDEN II		VARIANCE	(1.61)	(1.89)	(1.83)	(0.91)	0.18	(2.19)	(0.82)	0.85	2.63	0.74	(0.57)	(2.20)	(0.67)
		CONS PER CUST	13.46	13.18	13.24	14.16	15.25	12.88	14.25	15.92	17.70	15.81	14.50	12.87	14.40
		# CUST	12,137	10,087	12,153	11,337	9,035	13,587	12,361	10,139	12,169	12,101	10,063	12,145	137,314
		CONSUMPTION	163,371	132,934	160,873	160,546	137,782	175,033	176,163	161,450	215,333	191,266	145,869	156,302	1,976,922
		MONTH	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE H	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	TOTALS

UNITED WATER DELAWARE RESIDENTIAL CONSUMPTION 2009

Consumption is in thousands of gallons